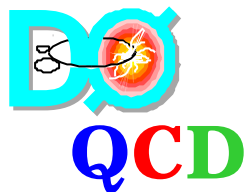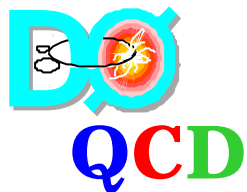# QCD DiJets

- **QCD Dijets**
  - Why Study them?
  - Analysis strategy
- **Dijet Asymmetry**
  - Cuts
  - results
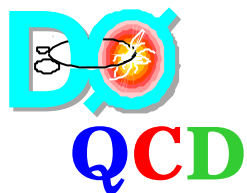- **To Do**

QCD DiJets

- **Why study them?**
  - **Good test of QCD**
    - Dijet final states arising from qq, qg, gg interactions
    - Angular distributions for these processes predicted to be similar -> ~roughly independent of pdf's
    - Parton-parton scattering peaked at small scattering angles/ new physics (eg compositeness) more isotropic

QCD DiJets

- **Variable definitions**
  - **We want to look at dijet angular distributions**
  - **To compare with theory, define the following varibles**

- **Leading dijet mass:**
  - $M_{jj}^2 = 2E_{T1}E_{T2}(\cosh(\eta_1 - \eta_2) - \cos(\phi_1 - \phi_2))$

- **Leading dijet χ variable**
  - $\chi = e^{|\eta_1 - \eta_2|} = (1 + \cos\theta^*)/(1 - \cos\theta^*)$

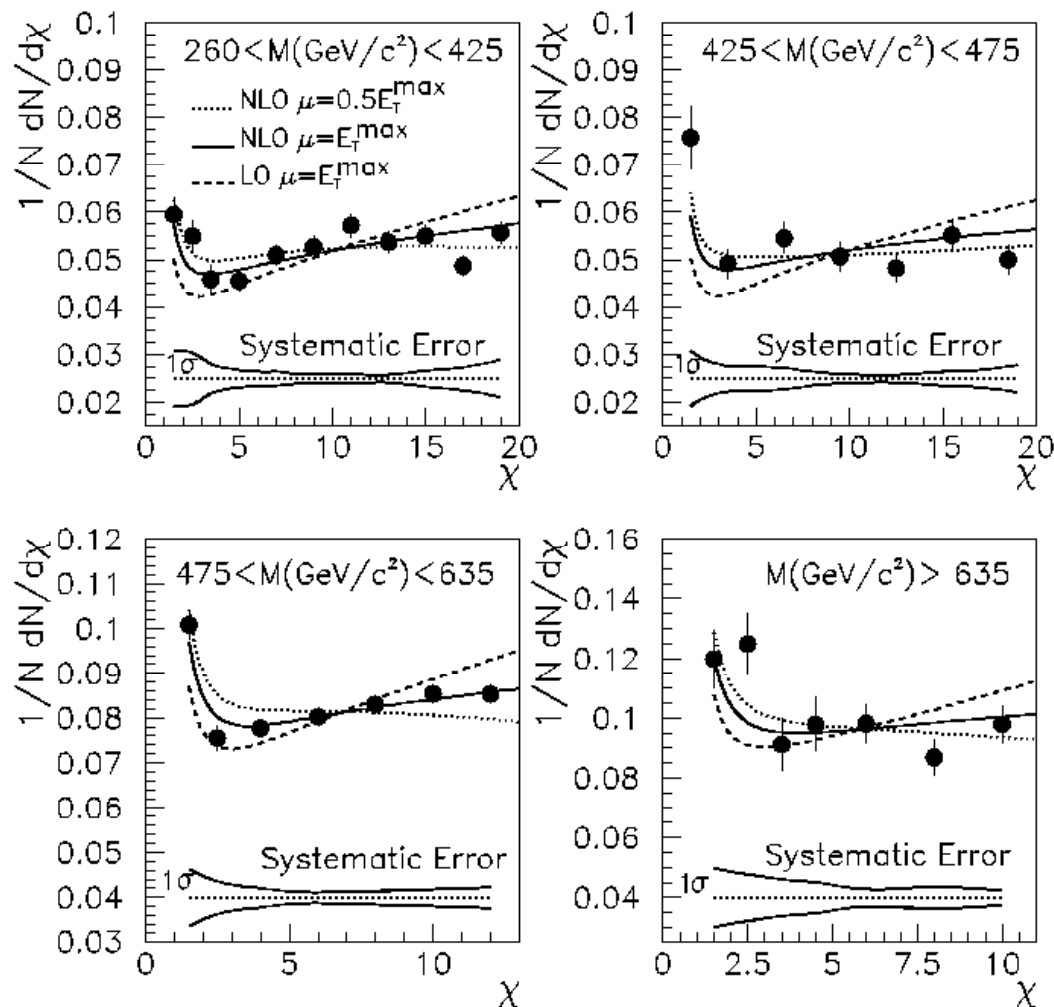**Results from Run I**

PRL 80 666 (98)

Systematic Error:
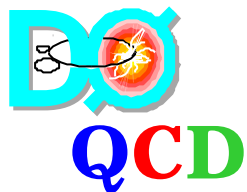
• Largest systematic uncertainty from eta dependence of calorimeter energy scale (~2% level)

QCD

- **Analysis Strategy**
  - Systematic Uncertainties
    - **Jet Energy Scale η dependence**
    - **Jet Resolutions**
    - **Trigger Acceptance**
   - **Cut acceptances**

QCD DiJets

- **Analysis Strategy**
  - Analysis Checklist
    - **Use JES from Photon-Jet events**
    - **Carry JES into full η region using dijets**
    - **Measure jet resolutions**
    - **Smear MC with jet resolutions**
    - **Calculate trigger/cut acceptance from MC**
    - **Make angular distributions vs. C for M_{jj} regions**
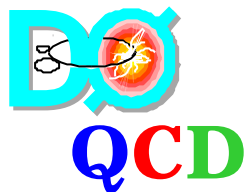   - **Compare with MC predictions of different L_c values**

QCD
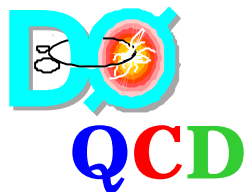
- **Dijet Asymmetry**
  - **Select exclusive dijet events with one jet in central region ($h < 0.7$) (central jet) and the other jet anywhere (probe jet)**
  - **Defined as:**
    - $A = (E_T^{probe} - E_T^{central})/(E_T^{probe} + E_T^{central})$
  - **Then relative response of probe jet response is:**
    - $R = E_T^{probe}/E_T^{central} = (1+A)/(1-A)$

  - **Can use this to:**
    - **Examine response h dependence in jets**
    - **Carry calibration into forward eta regions**

Data Sample and Cuts

QCD
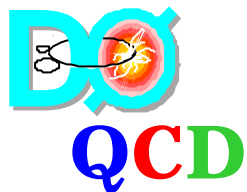
- **Data Sample**
  - **Alexanders p10.15.01 QCD stripped sample**
  - **Using triggers**
    - J3CJT7
    - 2JT_LO
    - JT_125TT
    - JT_95TT
    - JT_65TT
    - JT_45TT
    - JT_25TT
    - zero_bias
    - min_bias

QCD

- **Data Cuts**
  - **Event Cuts**
    - MET > 0.7 * jet.PT[0])
    - if (JCAL.JEthresh > 2000)
    - Vertex must have at least 3 tracks
    - |zvertex| < 50.0 cm
    - Two and only two jets passing jet quality cuts below
    - $\mathbf{Df}$ between the two jets must be within $\mathbf{p}$ +- 0.5 rads
  - **Jet Cuts**
    - HotFraction (highest ET cell)/(2nd highest cell) < 10
    - 0.05 < EMfrac < 0.95
    - CHfrac < 0.4
    - Jet N90 (# cells containing 90% of the jet energy) > 1
    - Jet E_T > 8.0 GeV

Data Sample and Cuts

QCD

- ## Jet Threshold Cuts

  - ### Central Jet Energy must satisfy:

Note: These thresholds are just an estimate. They should come from L1/L2/L3 turn on curves

Trigger	Jet Threshold
3CJT7	50.0 GeV
2JT_LO	10.0 GeV
JT_125TT	150.0 GeV
JT_95TT	100.0 GeV
JT_65TT	80.0 GeV
JT_45TT	60.0 GeV
JT_25TT	50.0 GeV
zero_bias	10.0 GeV
min_bias	10.0 GeV

Minimum Bias/Zero Bias

QCD

Minimum Bias and Zero Bias triggers are not clean dijet events – the rest (jet triggers) look good.

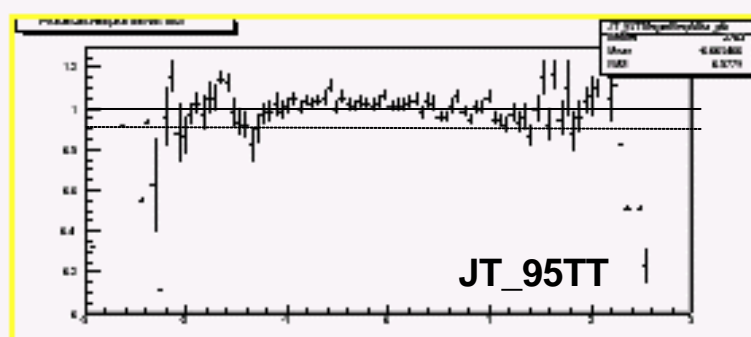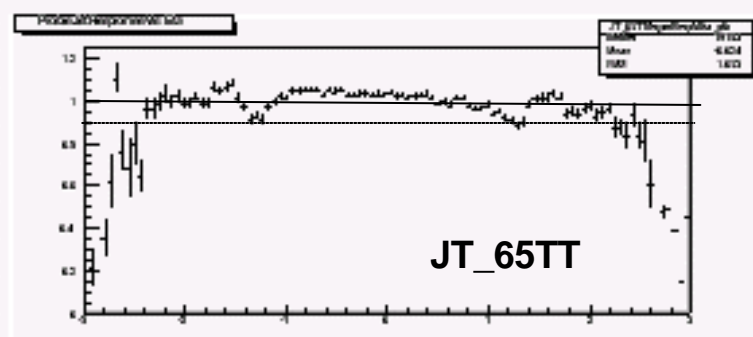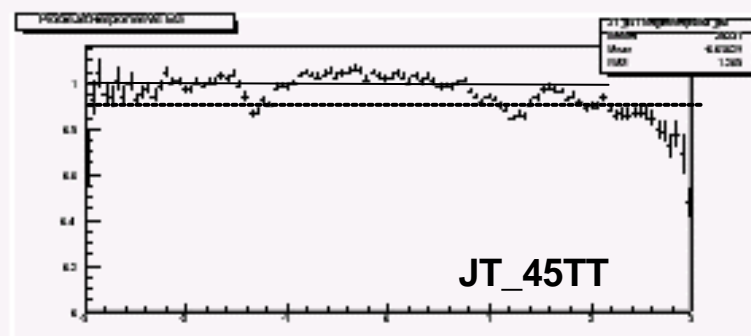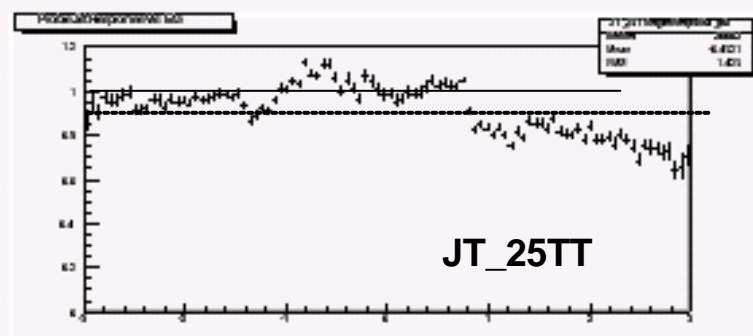# Probe Jet Response

25.0 GeV< $<E_T>$ < 35.0 GeV

35.0 GeV< $<E_T>$ < 45.0 GeV

45.0 GeV< $<E_T>$ < 60.0 GeV

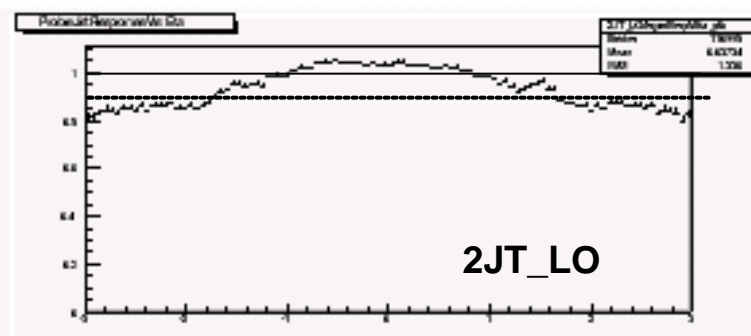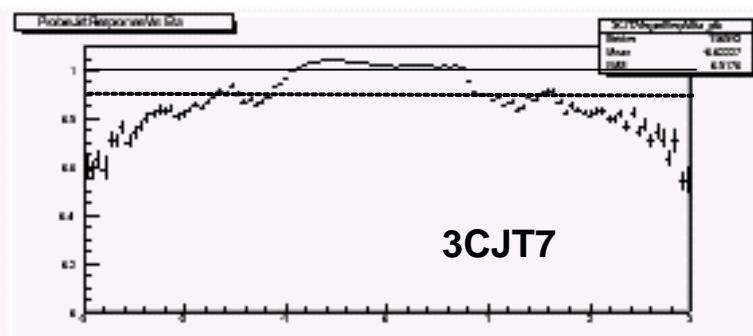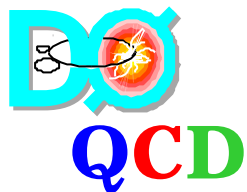60.0 GeV< $<E_T>$ < 90.0 GeV

90.0 GeV< $<E_T>$ < 125.0 GeV

$<E_T>$ > 125.0 GeV
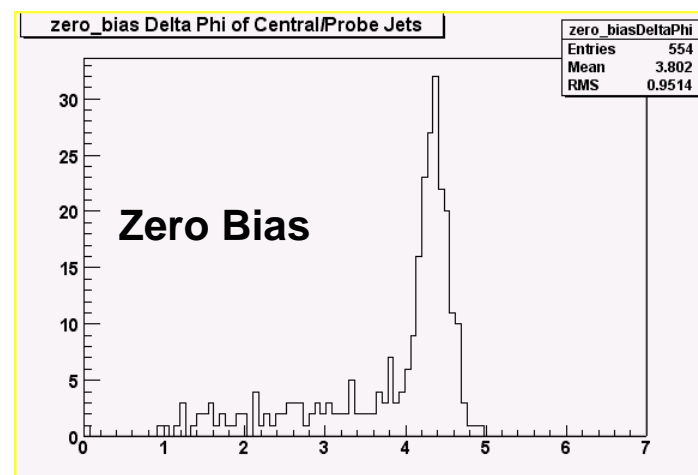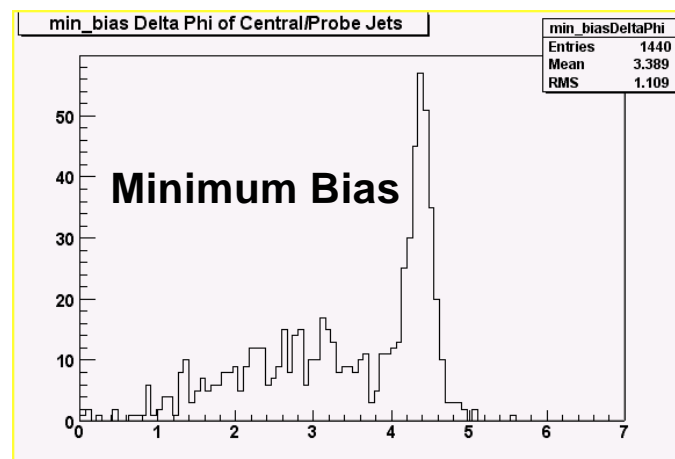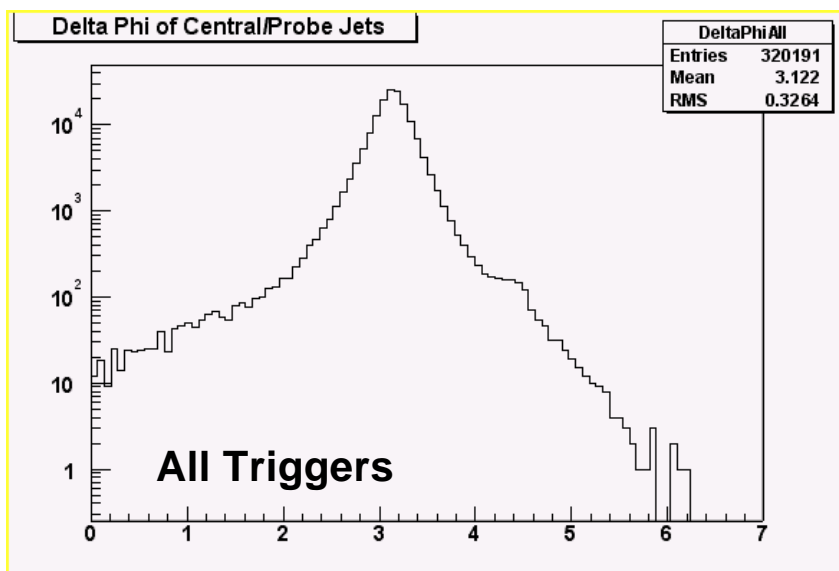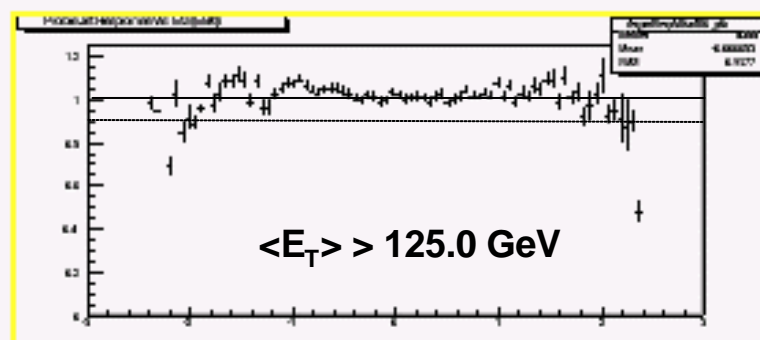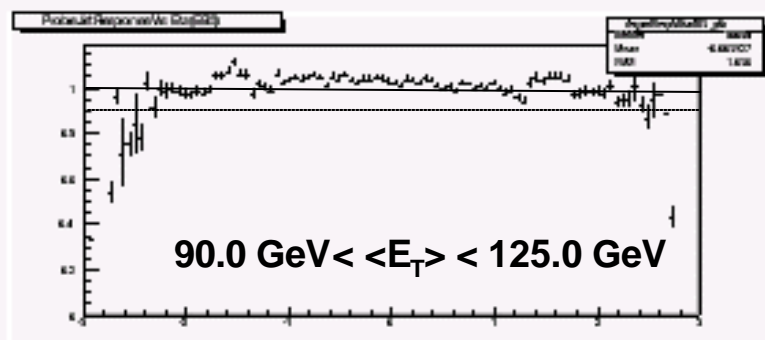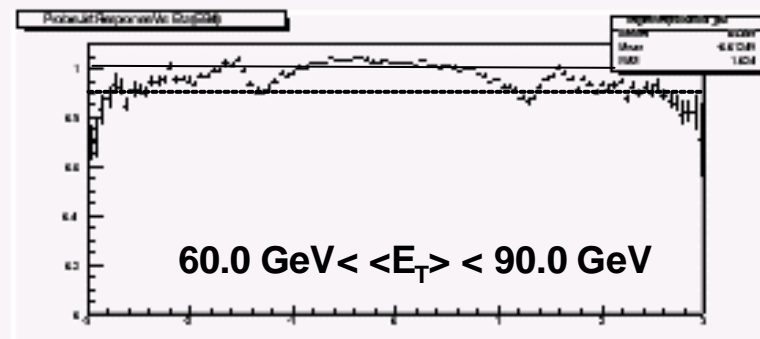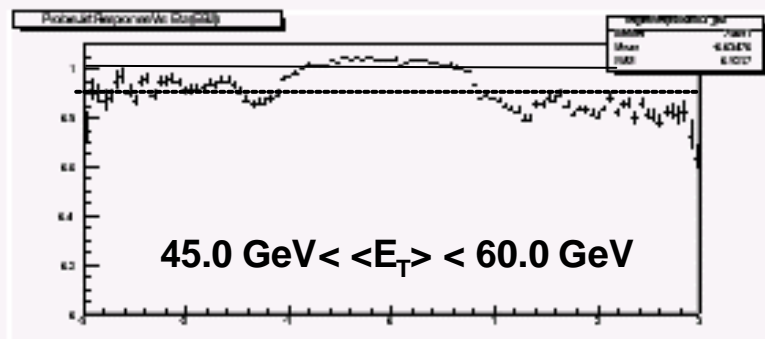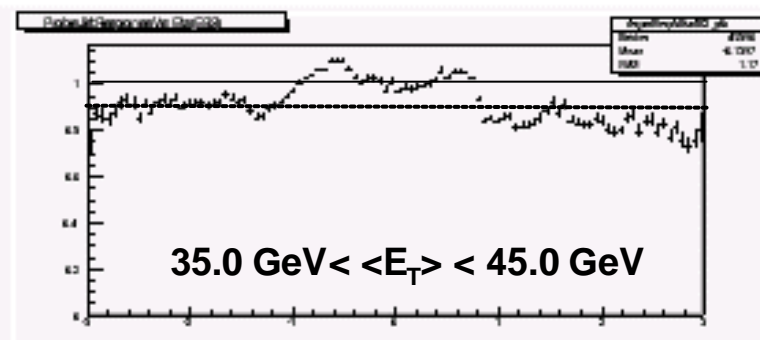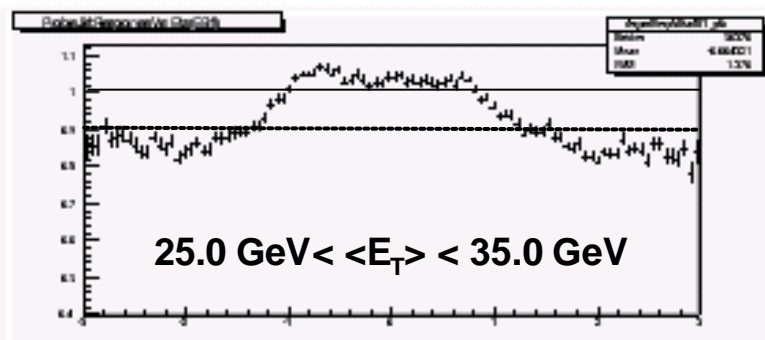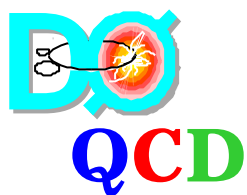
Probe Jet Response by Trigger

MPF method

- **Can also use dijet events and calculate the Missing E_T Projection Fraction (MPF)**

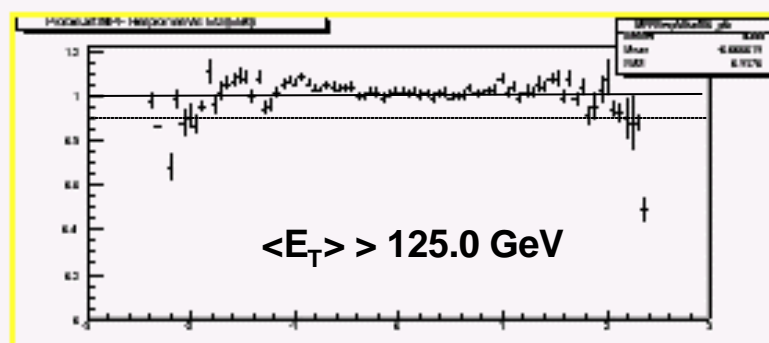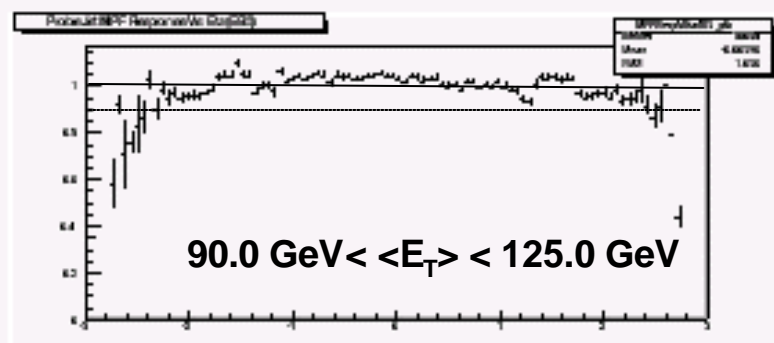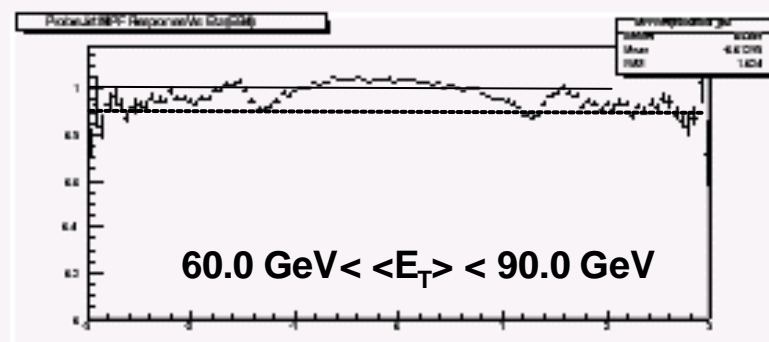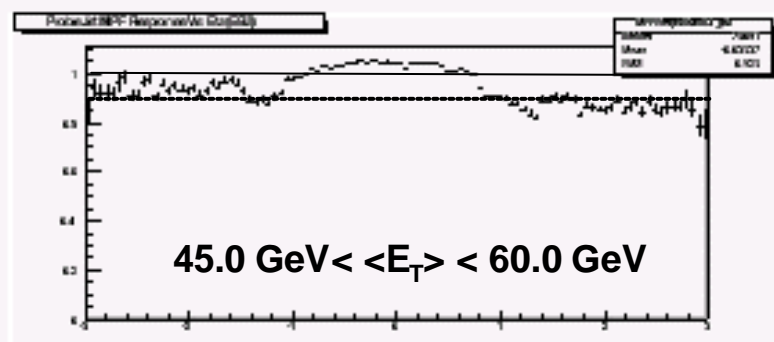- **MPF =** $$\frac{\vec{E_T} \cdot \hat{n}_T^{probe}}{E_T^{probe} + E_T^{central}}$$
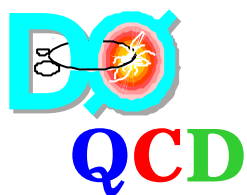
- **Probe Jet response = (1-MPF)/(1+MPF)**

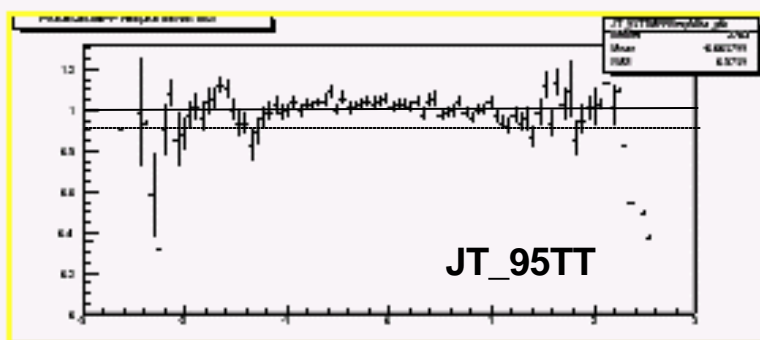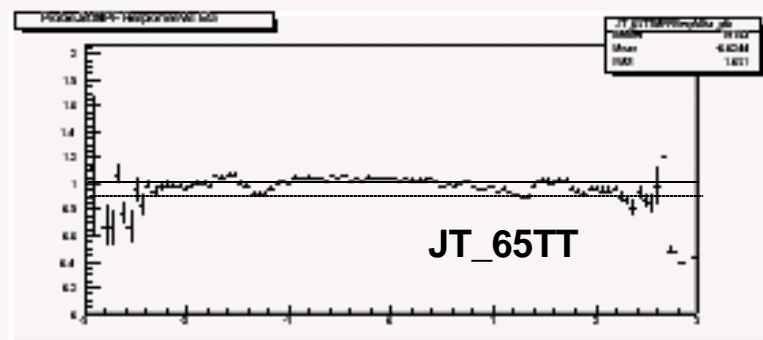 Since we are using entire calorimeter to balance P_T, this method is insensitive to out-of-cone showering effects

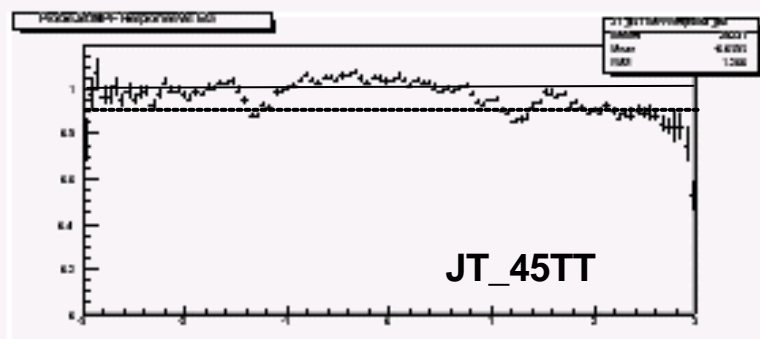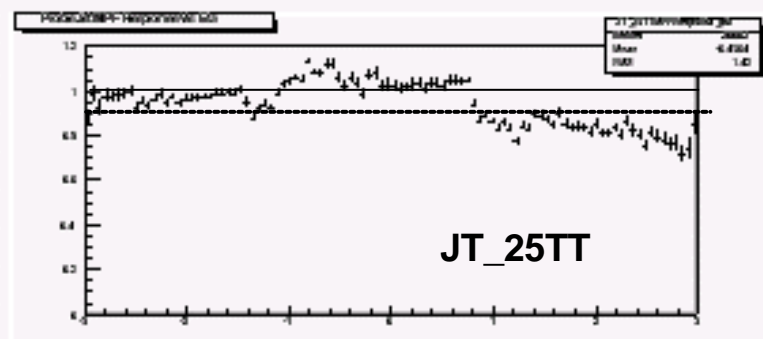# Dijet MPF Response

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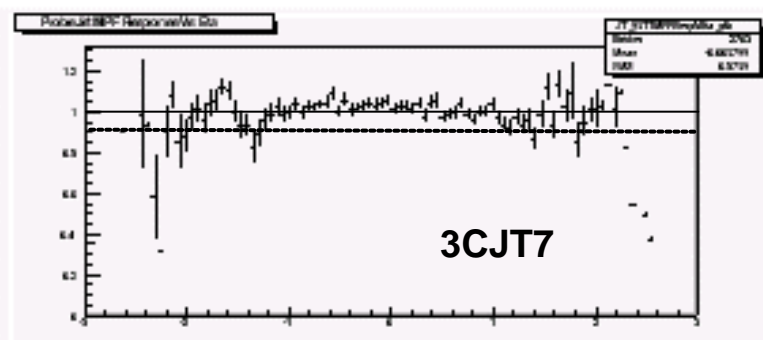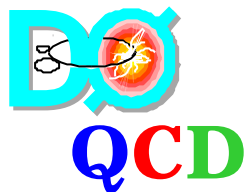60.0 GeV< <E_T> < 90.0 GeV
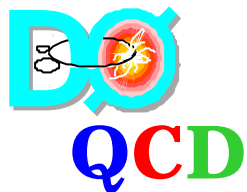
90.0 GeV< <E_T> < 125.0 GeV

<E_T> > 125.0 GeV

QCD
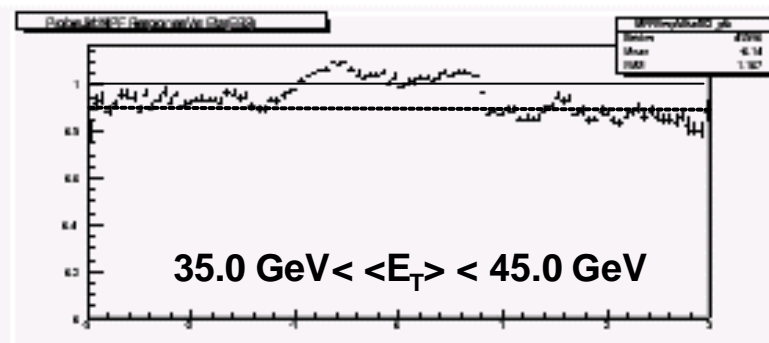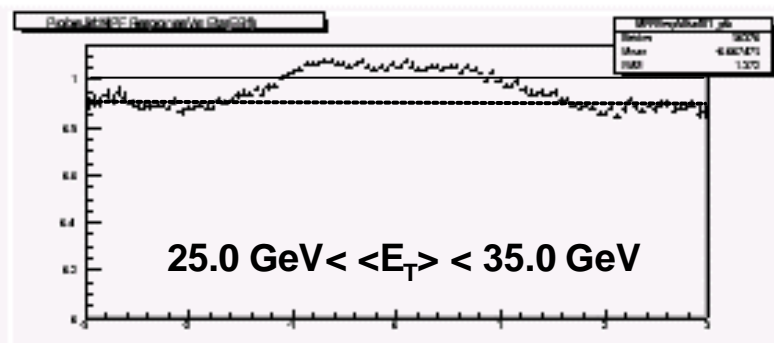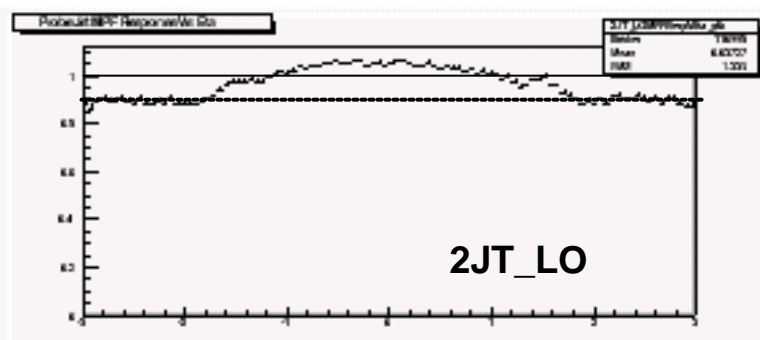
Dijet Asymmetry

- **Can also learn about the jet energy resolution from dijets**

  - **Making the approximation:**

    - $E_T^{\textbf{probe}} = E_T^{\textbf{central}}$ and $\boldsymbol{\sigma}(E_T^{\textbf{probe}}) = \boldsymbol{\sigma}(E_T^{\textbf{central}})$, then the width of the asymmetry distribution is directly proportional to $\boldsymbol{\sigma_{ET}}/\textbf{E}_\textbf{T}$.

    - This should be calculated for different $\boldsymbol{\eta}$ ranges.

Dijet analysis: Next Steps

QCD

- **Can also learn about the jet energy resolution from dijets**
  - **Making the approximation:**
    - $E_T^{probe} = E_T^{central}$ and $\sigma(E_T^{probe}) = \sigma(E_T^{central})$, then the width of the asymmetry distribution is directly proportional to σ_{ET}/E_T.

    - This should be calculated for different η ranges.

- **Trigger efficiencies – fold these in**
- **Monte Carlo**